Basewide Energy Systems Plan

Executive Summary

Final Report

Fort Rucker, Alabama

February 1983

Prepared For
MOBILE DISTRICT CORPS OF ENGINEERS
MOBILE, ALABAMA
CONTRACT DACA01-77-C-0094

Prepared By
BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited. Distribution A. Approved for public release.

Marie Wakefield,
Librarian Engineering

Basewide Energy Systems Plan

Executive Summary

Final Report

Fort Rucker, Alabama

February 1983

Prepared For
MOBILE DISTRICT CORPS OF ENGINEERS
MOBILE, ALABAMA
CONTRACT DACA01-77-C-0094

Prepared By
BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

EXECUTIVE SUMMARY - INCREMENTS A, B, C, D and E

Included in this summary are the results of the first five increments of the Basewide Energy Systems Plan for Fort Rucker, Alabama. This plan includes analyses and recommendations of energy conservation projects for the reduction of the installation's present energy consumption. The savings figures presented in this summary can only be realized after all projects have been implemented. Black & Veatch has developed projects that would meet funding requirements for the energy conservation program. Furthermore, the recommended projects provide partial compliance with the energy conservation requirement for the installation as outlined in the Army Facilities Energy Plan. This summary presents data on the following:

- Existing energy consumption and the basewide energy use model
- Source energy reductions due to energy conservation techniques for buildings and their systems
- Application of solar energy to reduce fossil fuel consumption
- Use of solid waste as an alternate energy source
- Savings utilizing central energy monitoring and control systems (EMCS)

Tables 1 and 2 (all tables are included in Appendix A) present information pertaining to the physical descriptions and energy consumption of 35 typical buildings used to verify historical energy consumption in the development of the basewide energy use model. This model

was then utilized as the foundation for energy conservation project analyses and recommendations. Table 3 summarizes the daily personnel occupancy for each typical building. Tables 1, 2 and 3 also provide information which was used to estimate source energy consumption for similar buildings within the designated groupings.

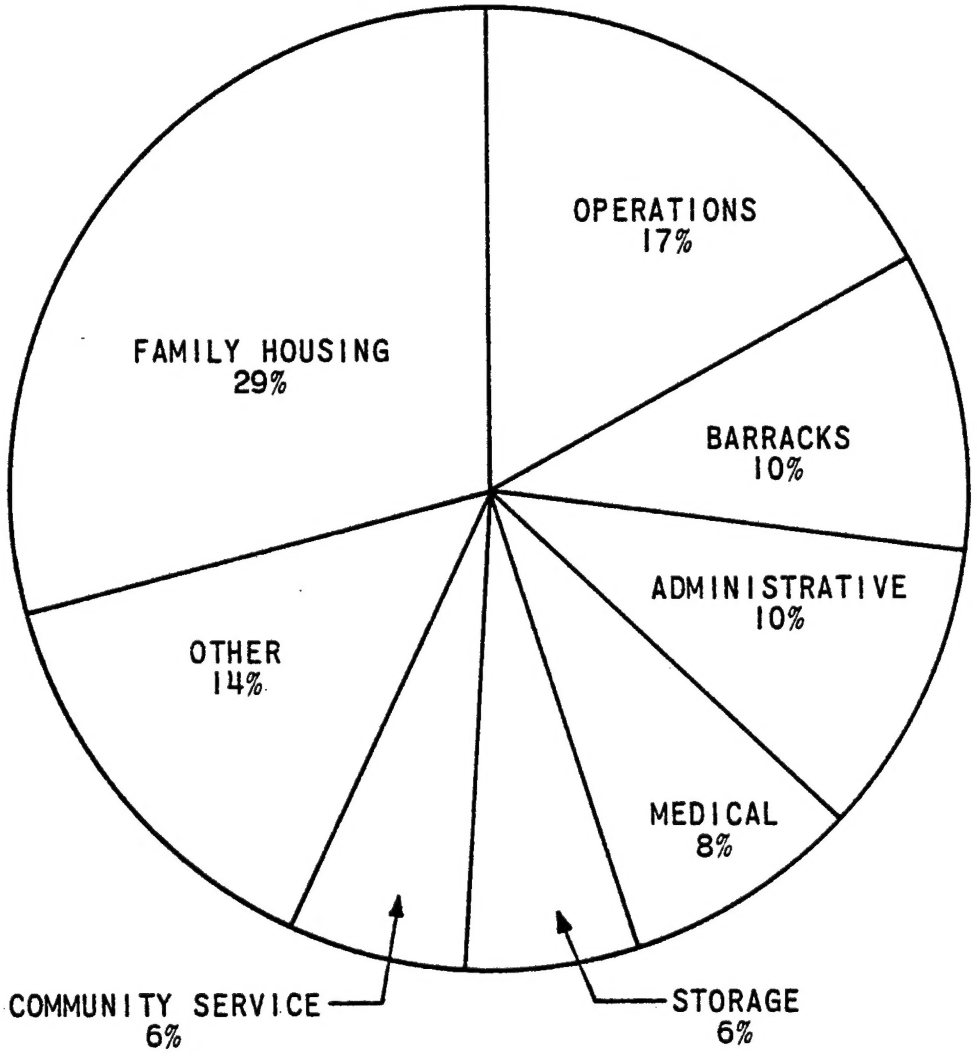
The foundation for the basewide energy model was the estimated average annual source energy consumed by each of the significant building groups, as indicated in Table 4, totalling 1,822,240 mega-Btu per year. The model was within 2 percent of the FY 75 historical source energy consumption shown below.

FY 75 Source Energy Consumption in Btu x 10^6	
Electricity	918,279
Natural Gas	759,502
Propane Gas	6,947
Fuel Oil No. 2	90,484
Fuel Oil No. 5	22,982
TOTAL	1,798,194

The estimated annual percentage of source energy consumption for all building types contributing to the historical basewide annual total consumed during base year 1975, is shown on Figure 1.

Further explanation of the historical energy consumption and development of the basewide energy model can be found in the Energy Use Survey.

The total estimated source energy savings due to implementation of all feasible energy conservation projects developed within Increments A, B, C, D, and E of this study is 630,344 mega-Btu per year. These



FY'75 CONSUMPTION

(1,798,194 x 10^6 BTU'S)

FIGURE 1

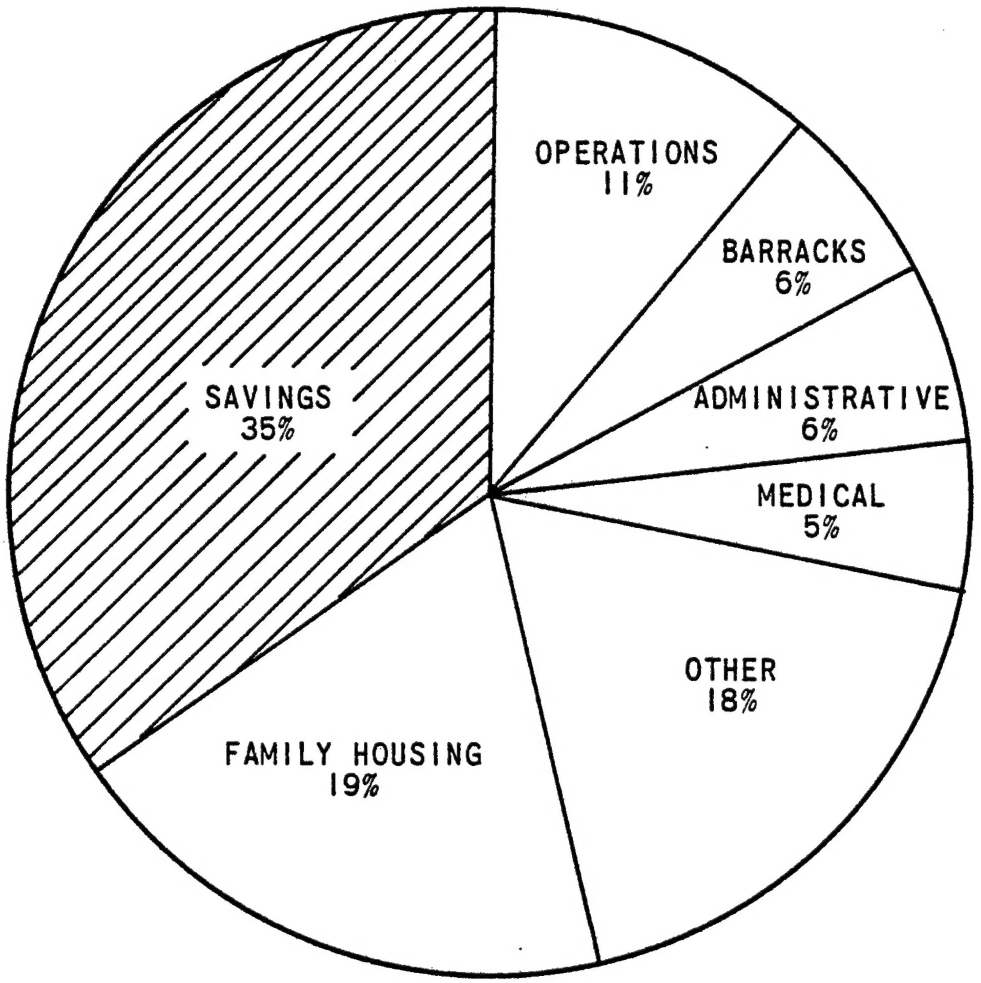
projects consisted of various architectural improvements, and mechanical and electrical system modifications, and are summarized in Tables 5 and 6.

Table 5 presents, by building type, the source energy savings and the percent basewide reduction to be realized by implementation of each of the projects. Figure 2 illustrates the combined effect of the recommended energy saving improvements, as compared to the FY 1975 source energy expenditure. Our calculations indicate a savings of 630,344 mega-Btu per year, approximately 35 percent, over the base year (1975). Figure 3 illustrates the allocation of the energy conservation projects savings for significant building groups.

Table 6 was developed to give a prioritized schedule, in order of fiscal year, for implementing the recommended energy conservation projects. A detailed analysis of the projects listed in Tables 5 and 6, and further explanation of the energy conservation analysis can be found in the Energy Use Survey.

Nine concepts for the reduction of Fort Rucker's dependence on nonrenewable energy sources by utilizing solar energy, a renewable energy source, were evaluated. This evaluation resulted in the recommendation of Project No. 43500 which indicated a total savings of 2,040 mega-Btu per year. The nine concepts and analyses are presented in the Solar Energy Applications and Evaluation.

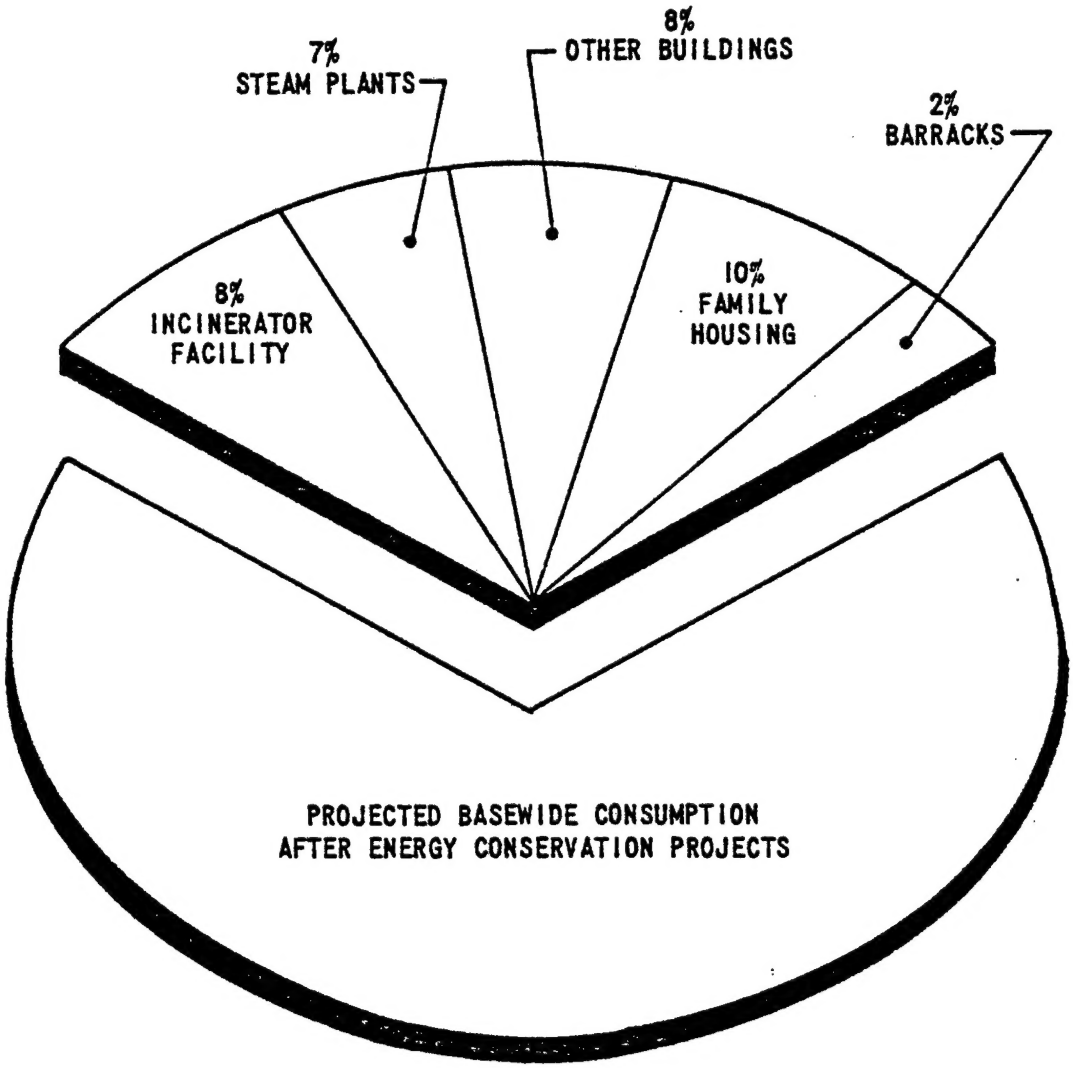
The report on Energy Monitoring and Control Systems (EMCS) includes recommendations for an extension of the existing system (design completed by Newcomb and Boyd, Consulting Engineers) and the utilization of an FM



BASEWIDE CONSUMPTION AFTER ENERGY CONSERVATION PROJECTS

(1,169,489 x 10^6 BTU'S)

FIGURE 2



ALLOCATION OF ENERGY
CONSERVATION PROJECTS SAVINGS
FOR SIGNIFICANT BUILDING GROUPS

FIGURE 3

control system. An extension of the existing system (EMCS Phase III) would result in a savings of 28,744 mega-Btu per year, while the FM control system would save 75,308 mega-Btu per year.

The investigation of solid waste for reducing source energy consumption at Fort Rucker resulted in the development of Project No. 224. This project recommends the installation of a solid waste burning incinerator facility to provide steam to the existing steam distribution system. The proposed plant would enable the installation to retire one of the two existing heating plants (Nos. 6021 or 4701), thereby reducing fuel oil and electric consumption totalling 142,535 mega-Btu per year. The details and descriptions of the systems analyzed can be found in the report, Total Energy, Selective Energy, and Central Boiler Plants.

The incorporation of a total energy or selective energy (TE/SE) system at this installation is not recommended. The application of TE/SE systems was rejected due to the relative low steam demand and the high cost of expanding the existing steam distribution system.

EXECUTIVE SUMMARY-INCREMENTS F AND G

Increment F - Facilities Engineer Conservation Measures.
Increment G - Maintenance, Repair, and Minor Construction Projects.

This is a summary of the two phases of work that were started after the completion of Increments A, B, C, D, and E in May of 1980. Increments F and G were completed in December, 1982.

The purpose of Increment F of the Basewide Energy Systems Plan is to identify and develop recommendations that can be used by Fort Rucker in preparing its energy management plan. Included are a number of comparatively low cost projects, recommendations for training, and prioritized lists of possible energy conservation measures. Increment G identified maintenance, repair, and minor construction projects for the purpose of conserving energy. These are energy conservation projects that did not meet ECIP criteria or did not fit the ECIP program at the time that the remainder of the study was completed.

The average costs of energy for FY 1981 are given in Table 7. These costs have been used as the basis for determining the dollar savings due to energy conservation.

Projects developed within the scope of Increments F and G of the study are summarized in Tables 8 and 9 respectively, and are prioritized by their E/C ratio. The E/C ratio is defined as the ratio of yearly energy savings in million Btu to the cost estimate in thousands of dollars. Any project showing a payback of 15 years or less is recommended. Material and labor cost estimates are representative of April, 1981 prices.

Five 1391's were prepared which combined twelve of the projects developed under Increments F and G. The ECIP documentation for these projects appears in Appendix B of Volume V.

The first project, Ceiling Fans and Destratifiers, involves installation of ceiling fans in 26 high ceiling buildings and portable de-stratifying fans in aircraft maintenance hangars.

The Window Treatment project is a combination of three projects: window insulation for 76 buildings where 100 percent visibility is not needed and diffuse sunlight is beneficial, application of solar film to nine administrative type buildings, and installation of insulated panels over unnecessary windows in ten buildings.

The Automatic Chiller Condenser Tube Cleaning project involves installation of a free-floating brush in all chiller tubes and one four-way flow reversing valve in each chiller in ten buildings.

Weatherization is a combination of four projects: weatherstripping exterior doors in 175 buildings, application of blown-on insulation on the walls and/or ceilings of 47 buildings, installation of aluminum storm windows on 155 buildings, and addition of insulation to the underside of the floor in 24 buildings.

The fifth project involves expansion of the EMCS and FM Control Systems.

The total estimated source energy savings due to implementation of all the recommended projects in Increment F is 294,543 mega-Btu per year. The total estimated savings due to implementation of all recommended projects in Increment G is 144,205 mega-Btu per year.

CONCLUSION

The projected future energy savings at Fort Rucker due to implementation of the scheduled ECIP projects developed under Increments A, B, C, D and E, construction of the Solid Waste Incinerator Facility, and implementation of the recommended projects from Increments F and G, is shown in Figure 4. The following projects comprise the "Scheduled ECIP's" section of Figure 4:

T-41100	Insulated Panels, Storm Windows, and Weatherstrip Doors in Permanent Buildings.
T-41200	Insulation, Weatherstripping, and Storm Windows in Temporary Buildings.
T-41300	Storm Windows, Weatherstrip Doors and Kitchen Lighting Fixture in Family Housing.
T-41500	FM Radio Control System.
T-42200	Family Housing Equipment Modifications.
T-42400	Steam Plant Modifications.
T-44500	EMCS Phase III.

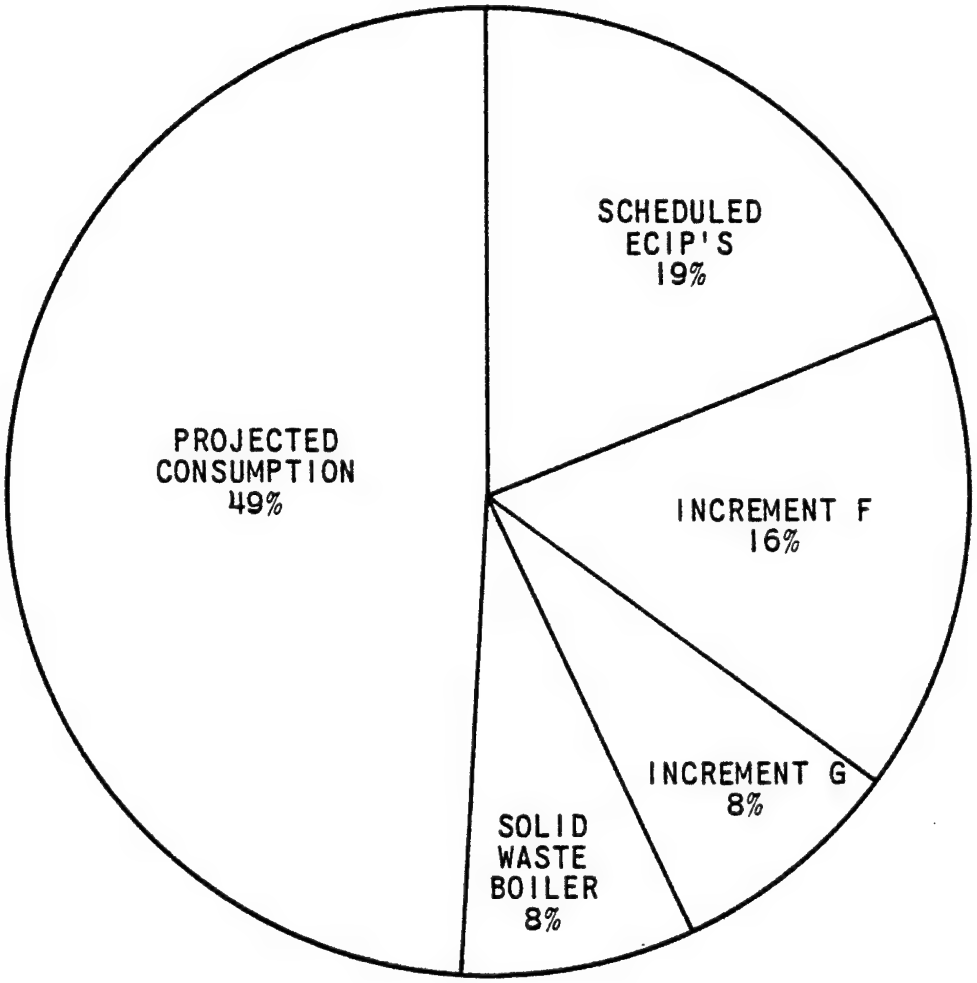
Figure 5 is a forecast of future energy costs at Fort Rucker. The graph compares how costs could escalate if no energy conservation projects were implemented versus energy costs if all cost effective projects are implemented. The energy conservation projects are assumed to be implemented in the following three phases:

Phase I - Scheduled ECIP projects

Phase II - Solid Waste Incinerator Facility

Phase III - Increments F and G projects

Figure 5 does not account for new building construction.



FORT RUCKER
BASEWIDE CONSUMPTION FY'81

FIGURE 4

EFFECT OF ESCALATION AND ENERGY
CONSERVATION ON FUEL COST

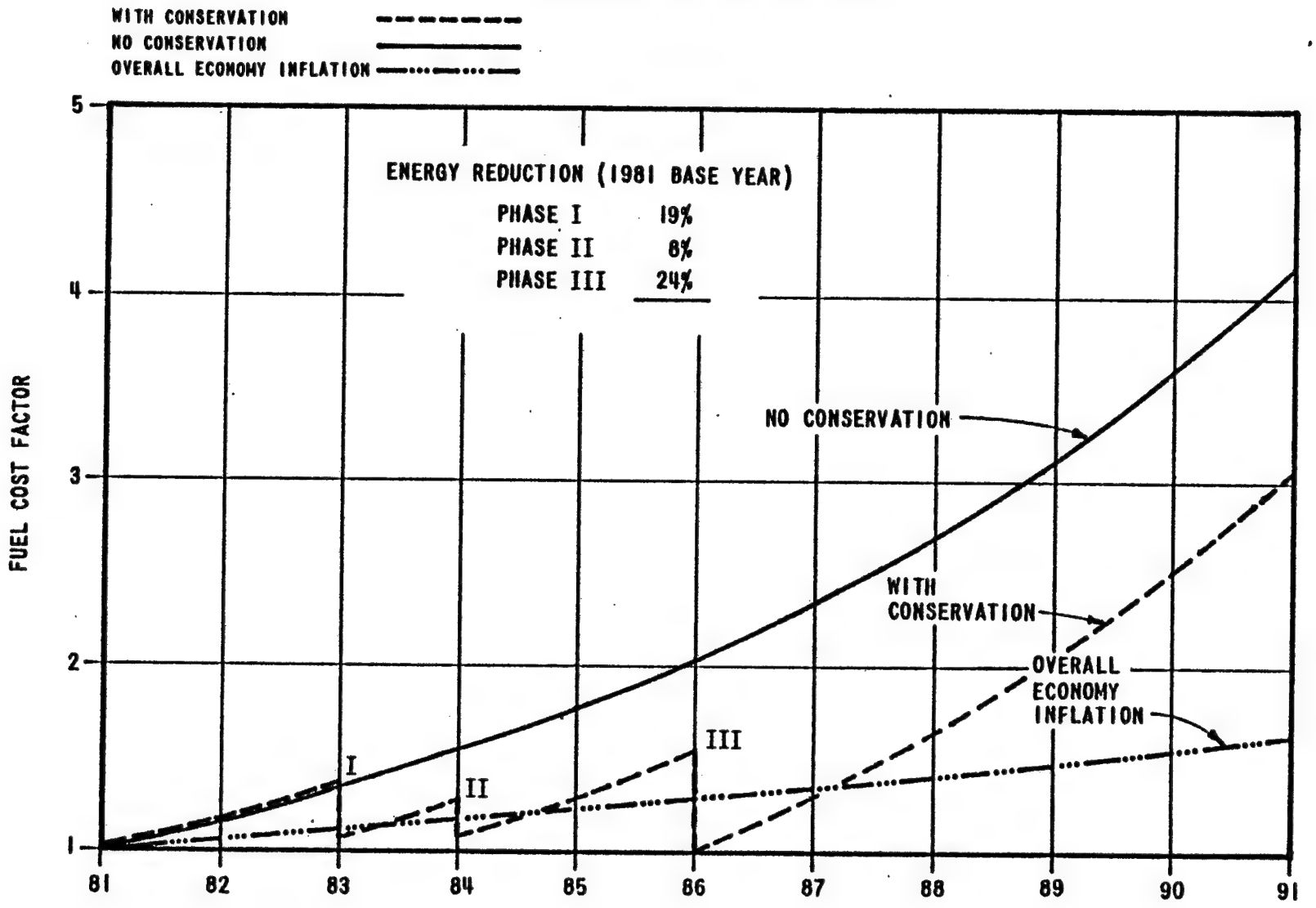


FIGURE 5

APPENDIX

TABLES

TABLE I
TYPICAL BUILDING CONSTRUCTION DATA
FORT RUCKER

GROUP NO.	BLDG.	BUILDING DESCRIPTION	NO. FLS.	CONSTRUCTION					"U" VALUES					WINDOW SQ. FT.	AREA (FT.²)	COOLING		HEATING		PEAK TONS LOAD MBH		DOMESTIC HOT WATER	
				ROOF	WALL	FLOOR	WINDOW	DOOR	ROOF	WALL	FLOOR	WINDOW	DOOR			SYSTEM	CAP. (TONS)	SYSTEM	FUEL	GAIN	LOSS	CAP. (G)	FUEL
A-1	8700	USAARL HDQTRS.	1	COMPOSITE SHINGLES	T & G ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.23	.53	1.13 1.06	.49 .47	236	2250	SPLIT SYSTEM	9	B.P. 6795	STEAM	48.3	109.5	80	STEAM ELEC.
A-2	612	AIRCRAFT MAINT. OFFICE	2	BUILT-UP	BRICK ON CONC. FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.10	.25	—	1.13 1.06	.55	1084	16602	WATER COOLED CHILLER	42	B.P. 1102	STEAM	78.6	202.6	50	GAS
A-3	704	VEHICLE MAINT. OFFICE	1	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.05	.36	.54	1.13 1.06	.49 .47	189	720	WINDOW UNITS	2	CENTRAL HTR.	GAS OIL	5.9	41.2	40	GAS
B-1	4509	BARRACKS	3	BUILT-UP	BRICK ON CONC. FRAME	TILE, VENTED CRAWL SPACE	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.04	.29	.52 .40	1.13 1.06	.85	4868	50643	CENTRAL CHILLER PLANT	87	B.P. 6701	STEAM TO HW	229.0	644.0	200	STEAM
B-2	313	BOQ	2	BUILT-UP	BRICK ON CONC. FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.16	.29	—	1.13 1.06	.55	1830	18133	ABSORPT CHILLER	40	B.P. 311	STEAM TO HW	107.0	250.8	150	STEAM
B-3	6749	BARRACKS	1	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.06	.23	.48	1.13 1.06	.49 .47	384	4350	NONE	—	B.P. 6795	STEAM	—	140.3	75	GAS
B-4	129	BOQ	2	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.05	.36	.54	1.13 1.06	.49 .47	744	8044	PACKAGE	15	BOILER	GAS	90.1	179.1	150	GAS
B-5	6904	BARRACKS	2	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.05	.36	.54	1.13 1.06	.49 .47	744	8044	NONE	—	BOILER	OIL	—	173.1	100	GAS
C-1	3712	SUNDAY SCHOOL CLASSROOMS	2	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.56	.84	1.13 1.06	.49 .47	436	5310	WINDOW UNIT	1	BOILER	OIL	5.16	172.2	15	OIL
C-2	3710	STORAGE & DRIVERS TRAINING	1	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.05	.36	.54	1.13 1.06	.49 .47	270	3000	NONE	—	FURNACE UNIT HTRS.	GAS	—	88.1	—	NONE
C-3	8740	MEDICAL SUPPLY	1	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.23	.53	1.13 1.06	.49 .47	288	4082	WINDOW UNITS	16	B.P. 6795	STEAM	80.0	181.1	150	STEAM
C-4	207	YOUTH CLUB	2	ASPHALT SHINGLES	WOOD SIDING & FRAME	LINOLEUM, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.27	.32	.61	1.13 1.06	.49 .47	1588	21290	CENTRAL	58	BOILER	GAS	159.4	389.0	50	GAS (NIU)*
E-1	4508	MESS HALL	1	BUILT-UP	BRICK ON CONC. FRAME	TILE, CLOSED CRAWL SPACE	SINGLE CLEAR GLASS	METAL HOLLOW CORE	.23	.32	.28	1.13 1.06	.55	1317	11334	CENTRAL CHILLER	40	B.P. 6701	STEAM	61.9	212.0	200	STEAM
F-1	21517	SINGLE FAMILY HOUSING	1	ASPHALT SHINGLES	BRICK ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.07	.26	—	1.13 1.06	.49 .47	285	1570	SPLIT SYSTEM	4	FURNACE	GAS	14.1	41.1	30	GAS
F-2	22460	DUPLEX FAMILY HOUSING	1	ASPHALT SHINGLES	WOOD SIDING & BRICK	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.11	.16	—	1.13 1.06	.49 .47	455	2752	CENTRAL	9	FURNACE	GAS	20.8	61.1	50	GAS
H-1	301	HOSPITAL	2	BUILT-UP	BRICK ON CONC. BLOCK	TILE, VENTED CRAWL SPACE	SINGLE CLEAR GLASS	METAL HOLLOW CORE	.10	.37	.61	1.13 1.06	.55	850	93936	ABSORPT CHILLER	352	B.P. 311	STEAM	449.3	858.1	500	STEAM
H-2	8739	VISION RESEARCH	1	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.36	.54	1.13 1.06	.49 .47	144	4870	CENTRAL & WINDOW	13	B.P. 6795	STEAM	105.0	232.3	120	STEAM ELEC.
L-1	1012	LAUNDRY	1	METAL	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.54	.21	—	1.13 1.06	.49 .47	918	52551	WINDOW UNIT	1.25	NONE	—	10.1	—	N/A	—
M-1	4004	TRUCK MAINTENANCE	1	COMPOSITE SHINGLES	ASBESTOS ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.04	.27	—	1.13 1.06	.49 .47	231	3108	NONE	—	BOILER	OIL	—	78.8	42	ELEC.
M-2	6712	VEHICLE MAINTENANCE	1	BUILT-UP	CONCRETE & CMU	SLAB ON GRADE	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.11	.67 .51	—	1.13 1.06	.55	947	4817	NONE	—	B.P. 6701	STEAM	—	131.7	—	NONE
M-3	1813	WORK SHOP	1	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.04	.36	—	1.13 1.06	.49 .47	504	5389	WINDOW UNITS	2	BOILER	GAS	7.5	135.0	50	GAS
O-1	6410	GRAD FLIGHT. SUPPLY	1	ASPHALT SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.20	.54	1.13 1.06	.49 .47	535	2500	NONE	—	FURNACE	GAS	—	119.6	40	ELEC.
O-2	4511	BATTALION HEADQUARTERS	1	BUILT-UP	BRICK ON CONC. FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.06	.30	—	1.13 1.06	.55	1036	6140	CENTRAL CHILLER	40	B.P. 6701	STEAM	50.1	137.5	42	ELEC.
O-3	801	OFFICE & STORAGE	2	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.36	.47	1.13 1.06	.49 .47	446	5310	CENTRAL	6	BOILER	GAS	51.4	181.9	40	GAS
O-4	5205	CLASSROOM & AUDITORIUM	1	BUILT-UP	BRICK & CONC. CONC. FRAME	TILE, BASEMENT	NONE	STEEL HOLLOW CORE	.16	.27 .29	.54	—	.55	0	19933	ABSORPT CHILLER	101	B.P. 6021	STEAM	73.5	202.4	50	GAS
S-1	3208	STORAGE	2	COMPOSITE SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.36	.54	1.13 1.06	.49 .47	404	5310	NONE	—	BOILER	OIL	—	154.3	50	OIL (NIU)*
S-2	8009	WAREHOUSE	1	ASPHALT SHINGLES	ASBESTOS SHINGLE WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.27	—	1.13 1.06	.49 .47	280	3108	NONE	—	SPACE HTR.	ELEC.	—	7.05	—	NONE
S-3	1309	WAREHOUSE	1	ASPHALT SHINGLES	METAL ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.45	.68	.54	1.13 1.06	.49 .47	209	9000	NONE	—	UNIT HTRS.	GAS	—	318.6	40	GAS
S-4	105	BOOKSTORE/STORAGE	1	ASPHALT SHINGLES	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.20	.54	1.13 1.06	.49 .47	336	2350	CENTRAL	10	BOILER	GAS	48.1	108.5	—	NONE

*NIU:

TABLE I (CONT'D)
TYPICAL BUILDING CONSTRUCTION DATA
FORT RUCKER

GROUP NO.	BLDG.	BUILDING DESCRIPTION	NO. FLS	CONSTRUCTION					"U" VALUES					WINDOW SQ. FT.	AREA (FT.²)	COOLING		HEATING		PEAK TRNS LOAD MBH		DOMESTIC HOT WATER	
				ROOF	WALL	FLOOR	WINDOW	DOOR	ROOF	WALL	FLOOR	WINDOW	DOOR			SYSTEM	CAP. (TONS)	SYSTEM	FUEL	GAIN	LOSS	CAP. (G)	FUEL
U-1	9806	SEWAGE TREATMENT PLANT		←			NOT	APPLICABLE						→	776	NONE	—	SPACE HEATERS	ELECT	—	26.0		NONE
U-3	9804	PUMPING STATION		←			NOT	APPLICABLE						→	125	NONE	—	NONE	—	—	—	—	NONE
U-8	311	STEAM PLANT		←			NOT	APPLICABLE						→	23807	NONE	—	UNIT HEATERS	STEAM	—	149.3	—	NONE
Z		BUILDING ELECTRIC ONLY (INCLUDES OUTDOOR LIGHTING AND ELECTRIC AUXILIARIES)					← NOT APPLICABLE																→
V		VACANT BUILDINGS		←			NOT	APPLICABLE															→
X		BUILDING - NO UTILITIES		←			NOT	APPLICABLE						—									→

TABLE 2
TYPICAL BUILDING ENERGY CONSUMPTION DATA
FORT RUCKER

GROUP NO.	BLDG.	BUILDING DESCRIPTION	ANNUAL ENER. SOURCE CONSUMPTION BTU x 10^6			ELEC'L ENER. CONSUMPTION		BTU x 10^3 / FT^2
			FUEL	ELEC.	TOTAL	KW PEAK	KWH/YR	
A-1	8708	USAARL HDQTRS.	384	398	782	23	3%270	347.6
A-2	%12	AIRCRAFT MAINT. OFFICE	1382	%152	5534	129	357910	379.0
A-3	704	VEHICLE MAINT. OFFICE	141	96	237	6	8290	329.2
B-1	%509	BARRACKS	2670	3711	6381	126	319910	126.0
B-2	313	BOQ	3228	935	%163	13	80570	229.6
B-3	8749	BARRACKS	756	136	892	3	11700	205.1
B-4	129	BOQ	847	771	1618	38	66430	201.1
B-5	6904	BARRACKS	1091	330	1421	7	28%40	176.7
C-1	3712	SUNDAY SCHOOL CLASSROOMS	727	85	812	7	7340	152.9
C-2	3710	STORAGE & DRIVERS TRAINING	307	97	%04	3	8950	134.7
C-3	8740	MEDICAL SUPPLY	731	%59	1190	28	39550	291.5
C-4	207	YOUTH CLUB	1731	1093	282%	62	9%190	132.6
E-1	%508	MESS HALL	2%15	3982	6397	108	343300	564.4
F-1	21517	SINGLE FAMILY HOUSING	171	257	%28	9	22140	272.6
F-2	22%60	DUPLEX FAMILY HOUSING	276	%78	754	16	%1210	274.0
H-1	301	HOSPITAL	53499	25577	79076	%11	2377370	881.8
H-2	8733	VISION RESEARCH	810	12%3	2053	55	107160	%59.3
L-1	1012	LAUNDRY	23946	1379	25325	82	118890	%81.9
M-1	%008	TRUCK MAINTENANCE	180	143	323	10	12290	103.9
M-2	%712	VEHICLE MAINTENANCE	23%	68	302	2	5820	62.7
M-3	1%13	WORK SHOP	276	72	3%8	5	6220	64.7
O-1	6%10	GRAD FLIGHT. SUPPLY	505	70	575	2	603%	230.0
O-2	%511	BATTALION HEADQUARTERS	531	2325	2856	76	200520	%65.1
O-3	801	OFFICE & STORAGE	940	321	1261	15	27640	237.5
O-4	5205	CLASSROOM & AUDITORIUM	8191	1516	9707	32	130700	%87.0
S-1	3208	STORAGE	57%	39	613	1	3320	115.%
S-2	8009	WAREHOUSE	0	58	58	3	5000	18.7
S-3	1309	WAREHOUSE	711	779	1490	17	67160	165.6
S-4	105	BOOKSTORE/STORAGE	%33	285	718	15	2%400	305.5

TABLE 2 (CONT'D)
TYPICAL BUILDING ENERGY CONSUMPTION DATA
FORT RUCKER

GROUP NO.	BLDG.	BUILDING DESCRIPTION	ANNUAL ENER. SOURCE CONSUMPTION BTU x10^6			ELEC'L ENER. CONSUMPTION		BTU x 10^3 / FT^2
			FUEL	ELEC.	TOTAL	KW PEAK	KWH/YR	
U-1	9806	SEWAGE TREATMENT PLANT	0	8078	8078	N/A	696365	10409.8
U-3	9802	PUMPING STATION	0	11149	11149	N/A	961129	89192.0
U-4	311	STEAM PLANT	169	239	408	3	20600	17.1
Z		ELECTRIC ONLY	0	84952	84952	452	7323480	N/A
V		VACANT BUILDINGS	←		N/A			→
X		NO UTILITIES	←		N/A			→

TABLE 3

BUILDING OCCUPANCY

FORT RUCKER

GROUP NO.	BLDG.	BUILDING DESCRIPTION	NORMAL PEAK POPULATION	OCCUPANCY
A-1	8708	USAARL HDQTRS.	16	WEEKDAYS - 8:00 A.M. TO 5:00 P.M.
A-2	412	AIRCRAFT MAINT. OFFICE	52	WEEKDAYS - 7:30 A.M. TO 5:30 P.M.
A-3	704	VEH. MAINT. SHOP	5	WEEKDAYS - 7:30 A.M. TO 4:15 P.M.
B-1	4509	BARRACKS	184	OPEN 24 HOURS
B-2	313	B.O.Q.	40	OPEN 24 HOURS
B-3	8749	BARRACKS	23	OPEN 24 HOURS
B-4	129	B.O.Q.	16	OPEN 24 HOURS
B-5	6904	BARRACKS	43	OPEN 24 HOURS
C-1	3712	SUNDAY SCHOOL CLASSROOMS	40	WEEKDAYS - 7:30 A.M. TO 3:30 P.M. SUNDAY - 8:15 A.M. TO 11:00 A.M. & 3:30 P.M. TO 6:00 P.M.
C-2	3710	STORAGE & DRIVERS TRAINING	11	WEEKDAYS - 7:00 A.M. TO 3:00 P.M.
C-3	8740	MEDICAL SUPPLY	9	WEEKDAYS - 7:30 A.M. TO 4:15 P.M.
C-4	207	YOUTH CLUB	30	WEEKDAYS - 7:30 A.M. TO 8:00 P.M. SATURDAY - 1:00 P.M. TO 10:00 P.M.
E-1	4508	MESS HALL	300	7 DAYS A WEEK - 3:30 A.M. TO 8:30 P.M.
F-1	21517	SINGLE FAMILY HOUSING	4	OPEN 24 HOURS
F-2	22460	DUPLEX FAMILY HOUSING	8	OPEN 24 HOURS
H-1	301	HOSPITAL	529	OPEN 24 HOURS
H-2	8733	VISION RESEARCH	12	WEEKDAYS - 7:00 A.M. TO 5:00 P.M.
L-1	1012	LAUNDRY	22	WEEKDAYS - 7:30 A.M. TO 4:00 P.M.
M-1	4008	TRUCK MAINTENANCE	20	WEEKDAYS - 6:30 A.M. TO 3:30 P.M.
M-2	4712	VEHICLE MAINTENANCE	28	WEEKDAYS 8:00 A.M. TO 4:00 P.M.
M-3	1813	WORK SHOP	16	WEEKDAYS - 7:30 A.M. TO 4:15 P.M.
O-1	6410	GRAD FLIGHT SUPPLY	2	WEEKDAYS - 7:30 A.M. TO 4:15 P.M.
O-2	4511	BATALLION HEADQUARTERS	35	OPEN 24 HOURS
O-3	801	OFFICE & STORAGE	40	WEEKDAYS - 7:30 A.M. TO 4:15 P.M.
O-4	5205	CLASSROOM & AUDITORIUM	225	WEEKDAYS ; 7:30 A.M. TO 4:15 P.M. & 5:00 P.M. TO 9:00 P.M.
S-1	3208	STORAGE	N/A	ONLY WHEN SOMETHING IS BEING STORED OR REMOVED
S-2	8009	WAREHOUSE	2	WEEKDAYS - 7:00 A.M. TO 5:00 P.M.
S-3	1309	WAREHOUSE	8	WEEKDAYS - 7:30 A.M. TO 4:30 P.M.
S-4	105	BOOKSTORE/ STORAGE	21	WEEKDAYS - 10:00 A.M. TO 6:00 P.M.
U-1	9806	SEWAGE TREATMENT	2	OPEN 24 HOURS - 7 DAYS A WEEK
U-3	9804	PUMPING STATION	—	————
U-4	311	STEAM PLANT	1	OPEN 24 HOURS - 7 DAYS A WEEK

TABLE 4

Building Group Source Energy Consumption

Group	Description	Group Sq. Ft.	Total Source Consumption, Btu's x 10^6
A	Administrative	492,387	171,349
B	Barracks	1,091,182	202,585
C	Community Service	667,169	101,318
E	Dining	55,888	31,537
F	Family Housing	2,122,560	581,455
H	Hospital	235,584	148,883
L	Laundry	52,551	25,325
M	Maintenance	447,738	30,248
O	Operations	823,068	310,094
S	Supply and Storage, Warehouse	725,538	113,166
U-1	Sewage Treatment	3,987	8,078
U-3	Pump Houses	12,958	11,149
U-4	Boiler Plants	23,887	2,101
Z	Electric Only (includes outdoor lights)	83,040	84,952
		Total	1,822,240

ENERGY CONSERVATION PROJECTS
SOURCE ENERGY SAVINGS - FORT RUCKER, ALABAMA

BUILDING TYPE	ENERGY SAVINGS BTUx1,000,000	% BASEWIDE REDUCTION FY'75	PROJECT NUMBER
FAMILY HOUSING	84,974	4.73	T-41300
	46,026	2.56	T-41500
	45,746	2.54	T-42200
	176,746	9.83	
BARRACKS	14,384	0.80	T-42300
	14,279	0.79	T-41100
	6,312	0.35	T-41200
	1,652	0.09	T-41400
	6,192	0.34	T-44500
	42,819	2.37	
INCINERATOR FACILITY	142,535	7.93	224
STEAM PLANTS	20,734	1.15	T-42400
	98,183*	5.46	T-42500
	118,917	6.61	
OTHER BUILDINGS AFFECTED BY ECIP'S	29,282	1.63	T-41500
	62,293	3.46	T-41200
	21,578	1.20	T-41400
	3,694	0.21	T-42100
	2,040	0.11	T-43500
	6,628	0.37	T-42300
	1,260	0.07	T-41100
	22,552	1.25	T-44500
	149,327	8.30	
TOTAL	630,344	35.05	

*ENERGY SAVINGS WOULD BE 90,314 x 10^6 BTU'S IF BLDG. NO. 4701 IS RETIRED DUE TO INSTALLATION OF INCINERATOR FACILITY.

TABLE 5

ENERGY CONSERVATION PROJECTS DEVELOPED SCHEDULE - FORT RUCKER, ALABAMA

PROJECT TITLE	PROJECT NUMBER	RECOMMENDED FISCAL YEAR	COST $ x 1000	E/C RATIO	ENERGY SAVINGS BTUx1,000,000	YEARS PAYBACK	B/C RATIO
STORM WINDOWS, WEATHERSTRIP DOORS AND KITCHEN LIGHTING FIXTURE IN FAMILY HOUSING.	T-41300	1980	2,073	43.18	84,974	6.22	2.82
FM RADIO CONTROL SYSTEM	T-41500	1980	592	127.2	75,308	2.02	5.7
INSULATION, WEATHERSTRIPPING, AND STORM WINDOWS IN TEMPORARY BUILDINGS.	T-41200	1980	1,348	50.88	68,605	4.51	1.89
RELAMPING FLUORESCENT FIXTURES	T-41400	1980	289	80.45	23,230	1.7	4.70
TOTAL			4,302		252,117		
SOLID WASTE BURNING INCINERATOR FACILITY	224	1981	4,079	34.9	142,535	8.36	2.75
FAMILY HOUSING EQUIPMENT MODIFICATIONS	T-42200	1981	1,443	33.4	45,746	10.02	1.79
ADJUST FRESH AIR QUANTITIES	T-42300	1981	30	696.0	21,012	.41	43.68
STEAM PLANT MODIFICATIONS	T-42400	1981	354	58.6	20,734	3.97	4.99
INSULATE PANELS, STORM WINDOWS, AND WEATHER-STRIP DOORS IN PERMANENT BUILDINGS.	T-41100	1981	471	33.0	15,539	5.11	3.6
CEILING FANS IN AIRCRAFT HANGARS AND MAINTENANCE FACILITIES	T-42100	1981	60	61.75	3,694	3.81	5.02
SOLAR HEATING OF FIELDHOUSE SWIMMING POOL AND SHOWER WATER	T-43500	1981	112	18.3	2,040	10.7	1.77
TOTAL			6,549		251,300		
UPGRADE COOLING SYSTEMS	T-42500	1982	1,085	90.5	98,183	4.57	4.23
EMCS PHASE III	T-44500	1982	621	46.27	28,744	6.36	1.95
TOTAL			1,399		126,927		

TABLE 6

TABLE 7

FY81 Average
Energy Costs

Electricity	
Demand	$5.59/kW
kWh (without demand)	$0.0198/kWh
kWh (including demand)	$0.0370/kWh
Natural Gas	
Commodity (including demand)	$3.33/mcf
Propane	
Commodity	$0.5540/gal
Fuel Oil	
No. 2	$1.22/gal
No. 5	$0.87/gal

TABLE 8

Summary of Increment F Projects

Project	Location(s)	Energy Savings/Year MMBtu	Dollar Savings/Year	Payback Years	E/C	B/C	Contract Cost	Reference In-House Cost Material	Manhours		Pages Narr.	Calcs.
Reduction of Domestic Water Temperature in Barracks	10 Buildings	875	$ 4,104	.05	4,550	641	$ 192	-	Laborer	10	34	A17
Reduction of Ventilation Air Quantities	25 Buildings	38,090	243,854	.06	2,727	424	13,970	$6,704	A/C Mech.	228	27	A13
Cycle Pool Pumps	4 Buildings	1,334	5,629	.09	2,531	142	527	395	Electrician	6.5	33	A16
Filter Maintenance	Postwide	23,223	87,837	.10	2,285	206	10,164	2,338	Laborer	425	31	A15
Swimming Pool Cover	4,605	1,948	8,722	.20	1,104	153	1,765	-	-		12	A3
Receptacle Insulation	Family Housing	16,784	74,653	.32	696	80	24,115	4,005	Laborer	1,040	22	A9
Turn Off Hot Water	21 Buildings	1,013	4,749	.32	671	95	1,510	-	Plumber	42	19	A7
Insulate Water Heaters	120 Gal. - Nat. Gas	11	52	.43	494	70	22.40	13	Laborer	.5	37	A19
Insulate Water Heaters	80 Gal. - Nat. Gas	8.6	40	.48	440	62	19.57	10	Laborer	.5	37	A19
Bulb - Type Thermostats	Postwide	88,580	490,246	.47	383	60	231,441	194,800	A/C Mech.	1,148	41	A22
Insulate Water Heaters	40 Gal. - Nat. Gas	6.2	29	.58	367	502	16.75	7	Laborer	.5	37	A19
Insulate Water Heaters	120 Gal. - Electric	6.2	26	.92	258	24	23.82	14	Laborer	.5	37	A19

TABLE 8 (Cont'd)

Summary of Increment F Projects

Project	Location(s)	Energy Savings/Year MMBtu	Dollar Savings/Year	Payback Years	E/C	B/C	Contract Cost	Reference In-House Cost Material	Manhours		Pages Narr.	Calcs.
Thermostatic Steam Valves	8301	448	$ 2,101	.92	233	33	$ 1,924	$ 917	Plumber	28	39	A20
Insulate Water Heaters	80 Gal. - Elec.	4.7	20	1.04	229	21	20.43	11	Laborer	.5	37	A19
Weatherstrip Doors	175 Buildings	56,443	31,540	.92	194	28	29,111	7,860	Laborer	1,099	10	A2
Insulate Water Heaters	40 Gal. Elec.	3.3	14	1.24	192	17	17.31	8	Laborer	.5	37	A19
Duct Insulation in Unconditioned Spaces	4 Buildings	305	1,491	1.27	160	22	1,900	811	Laborer	56	16	A5
Reduce Infiltration in Family Housing	Family Housing	26,804	116,444	1.81	127	13	210,528	72,858	Laborer	7,120	23	A10
Variable Air Volume	4905	2,666	11,251	5.6	42	4	63,327	53,231	Electrician	500	29	A14
Replace Incandescent Lights	63 Buildings	13,884	82,742	4.9	35	4	402,588	239,314	Electrician	4,558	35	A18
Solar Film	9 Buildings	963	4,215	7.6	30	3	31,961	-	-		20	A8
Window Insulation	5 Buildings	149	878	7.0	24	4	6,148	2,729	Laborer	177	14	A4
Install Dropped Ceiling and Insulate Floor	8301	162	760	12.1	18	3	9,175	6,778	Laborer	124	40	A21
Window Insulation	71 Buildings	2,814	21,687	7.4	18	3	160,587	71,267	Laborer	4,620	14	A4
Roof Spray Cooling	5205	118	556	12.6	17	3	6,985	-	-	-	42	A23
Replace Incandescent Light Fixtures in Family Housing	Family Housing	4,757	23,811	30.7	7	6	731,237	463,525	Electrician	7,367	9	A1

TABLE 8 (Cont'd)

Summary of Increment F Projects

Project	Location(s)	Energy Savings/Year MMBtu	Dollar Savings/Year	Payback Years	E/C	B/C	Contract Cost	Reference In-House Cost Material	Manhours		Pages Narr.	Calcs.
Flush Valve Restrictors	52 Buildings	0	$ 4,944	2.55	0	4	$12,539	$ 7,776	Laborer	246	17	A6
Toilet Tank Dams	Family Housing	0	11,564	2.60	0	4	29,705	17,793	Laborer	616	25	A11
	and 149 Buildings	0	2,377	3.60	0	3	8,545	5,118	Laborer	177	25	A11

TABLE 9

Summary of Increment G Projects

Project	Location (s)	Energy Savings/Year MMBtu	Dollar Savings/Year	Payback Years	E/C	B/C	Contract Cost	In-House Cost Material	In-House Cost Manhours		Reference Pages Narr.	Reference Pages Calcs.
Barracks HVAC Modifications	6 Buildings	6,525	$41,019	.63	253	37	$25,812	10,771	A/C Mechanic Electrician	162 8	31	B13
FH Control System Expansion	38 Buildings	5,220	29,002	1.11	162	14	37,233	24,367	Electrician	388	20	B7
Automatic Chiller Condenser Tube Cleaning	301	6,885	52,877	.94	139	25	49,692	------	------		13	B4
Swimming Pool Heater	4605	1,228	5,759	1.78	120	17	10,260	9,685	Plumber	16	8	B1
Automatic Chiller Condenser Tube Cleaning	4901	3,306	13,951	2.49	95	9	34,777	------	------		13	B4
Automatic Chiller Condenser Tube Cleaning	5102	3,306	13,951	2.49	95	9	34,777	------	------		13	B4
De-stratifiers	5 Buildings	1,829	22,347	.91	90	26	20,283	16,922	Electrician	151	28	B12
Automatic Chiller Condenser Tube Cleaning	4701	1,552	6,549	3.08	77	7	20,198	------	------		13	B1
Automatic Chiller Condenser Tube Cleaning	4502	1,980	15,206	1.72	76	14	26,089	------	------		13	B1
Ceiling Fans	26 Buildings	7,152	41,649	2.40	73	12	98,051	42,204	Electrician	1,684	17	B6
EMCS Extension	5 Buildings	13,787	59,598	3.38	68	4	201,454	------	------		22	B8
Automatic Chiller Condenser Tube Cleaning	4905	1,584	12,165	2.03	64	12	24,644	------	------		13	B1

TABLE 9 (Cont'd)

Summary of Increment G Projects

Project	Location (s)	Energy Savings/Year MMBtu	Dollar Savings/Year	Payback Years	E/C	B/C	Contract Cost	In-House Cost Material	In-House Cost Manhours	Reference Pages Narr.	Reference Pages Calcs.
Automatic Chiller Condenser Tube Cleaning	6005	1,584	12,165	2.03	64	12	24,644	------	------	13	B1
Fluorescent Lighting Load Reduction	Postwide	15,072	92,394	2.90	56	7	268,596	195,235	Electrician 2,210	24	B9
Automatic Chiller Condenser Tube Cleaning	113	1,218	14,178	1.63	53	15	23,106	------	------	13	B1
Automatic Chiller Condenser Tube Cleaning	308	921	7,073	3.06	43	8	21,642	------	------	13	B1
Automatic Chiller Condenser Tube Cleaning	2908	891	4,179	5.15	41	6	21,536	------	------	13	B1
Floor Insulation	24 Buildings	21,200	99,428	6.33	34	5	629,827	395,891	Carpenter 8,182	37	B16
Boiler Upgrade	50 Buildings	13,140	79,132	5.50	30	5	434,690	295,074	Plumber 3,888	11	B3
Insulated Panels	10 Buildings	858	4,914	6.40	27	4	31,627	21,643	Carpenter 360	16	B5
Storm Windows	155 Buildings	14,384	83,702	7.26	24	4	608,383	452,388	Laborer 12,057	33	B14
Blown-on Insulation	47 Buildings	20,469	121,563	7.00	23	4	851,340	434,357	Insulator 21,420	35	B15
Heat Recovery From Dust Collector	8902	114	533	11.90	18	3	6,351	5,873	Sheet Metal 8 Carpenter 8	38	B17
Low Pressure Sodium Street Lighting	Postwide	3,156	7,131	51.90	9	.4	370,504	319,053	Electrician 1550	27	B11

TABLE 9 (Cont'd)

Summary of Increment G Projects

Project	Location (s)	Energy Savings/Year MMBtu	Dollar Savings/Year	Payback Years	E/C	B/C	Contract Cost	In-House Cost Material	In-House Cost Manhours		Reference Pages Narr.	Reference Pages Calcs.
Infrared Heating	7 Buidlings	528	3,695	23.0	6	1	84,865	51,711	Heat Mechanic	1040	10	B2
High Pressure Sodium Street Lighting	Postwide	2,041	4,612	77.6	6	.3	357,958	306,506	Electrician	1550	27	B11
Replace Flight Simulators	4910 and 5102	76,501	322,834	204.0	1	.1	65,856,000	------	------		26	B10